

DESCRIPTION

SERVO SYSTEM AND ENCODER

Technical Field

[0001]

An embodiment of this disclosure relates to a servo system and an encoder.

Background Art

[0002]

Patent Literature 1 discloses a servo system including: a servo motor; and a controller which acquires position data from an encoder and controls the rotation of the servo motor based on the position data.

Citation List

Patent Literature

[0003]

Patent Literature 1: Japanese Patent No. 4816988

Summary of Invention

Technical Problem

[0004]

In a servo system, communication is performed between a controller and an encoder. However, when a communication speed of the encoder does not correspond to the controller,

such communication cannot be performed. Accordingly, it is necessary to prepare encoders which respectively correspond to communication speeds of the controller thus giving rise to a drawback that the number of types of encoders is increased.

[0005]

The present invention has been made in view of such drawbacks, and it is an object of the present invention to provide a servo system and an encoder which can prevent the increase of types of encoders.

Solution to Problem

[0006]

To overcome the above-mentioned drawbacks, according to an aspect of the present invention, there is provided a servo system including: a motor configured wherein a movable element moves relative to a stator; an encoder configured to detect at least one of a position and a speed of the movable element; and a higher-level device configured to control an operation of the motor based on a detection result of the encoder, wherein the higher-level device includes a first command transmitter configured to transmit a first command signal for changing a communication speed between the encoder and the higher-level device to a second speed higher than a present first

speed to the encoder at the first speed, and the encoder includes a speed set-upper configured to change the communication speed between the encoder and the higher-level device to the second speed when the first command signal is received.

[0007]

According to another aspect of the present invention, the present invention also provides an encoder used for the servo system.

Advantageous Effects of Invention

[0008]

According to the present invention, the increase of the number of types of encoders can be prevented.

Brief Description of Drawings

[0009]

Fig. 1 is an explanatory view for describing the schematic configuration of a servo system according to one embodiment.

Fig. 2 is an explanatory view for describing a functional configuration of a controller.

Fig. 3 is an explanatory view for describing a functional configuration of an encoder.

Fig. 4A is an explanatory view for describing one

example of data structure of a change command.

Fig. 4B is an explanatory view for describing one example of data structure of a first response.

Fig. 5 is an explanatory view for describing one example of communication between the controller and the encoder.

Fig. 6 is an explanatory view for describing one example of a control steps performed between the controller and the encoder.

Fig. 7 is an explanatory view for describing a configurational example of the controller and the encoder.

Description of Embodiments

[0010]

Hereinafter, one embodiment is described with reference to drawings.

[0011]

A servo system according to one embodiment described hereinafter is applicable to various types of servo systems including a rotary type servo system and a linear type servo system. However, to facilitate the understanding of the servo system, the description is made by taking a rotary type servo system as an example, hereinafter. The present invention is applicable to other types of servo systems by applying an appropriate modification such as a

change in motor from a rotary-type motor to a linear-type motor or a change in object to be measured from a rotary-type disc to a linear-type linear scale. Accordingly, the detailed description of other types of servo systems is omitted.

[0012]

<1. Servo system>

Firstly, the schematic configuration of a servo system according to this embodiment is described with reference to Fig. 1.

[0013]

As shown in Fig. 1, a servo system S includes a servo motor SM and a controller CT. The servo motor SM includes a motor M and an encoder 100.

[0014]

The motor M is one example of a power generation source not including the encoder 100. The motor M is a rotary-type motor including a rotor and a stator (neither shown in the drawing) and in which the rotor rotates relative to the stator. The motor M outputs a rotational force by rotating a shaft SH which is fixed to the rotor about an axis AX. The rotation is one example of the movement, and the rotor corresponds to one example of a movable element.

[0015]

Although there may be a case where the motor M in the form of a single unit is referred to as a servo motor, in this embodiment, the motor which is configured to include the encoder 100 is referred to as the servo motor SM.

[0016]

The motor M is not particularly limited provided that the motor M is a motor where the encoder 100 can detect the position of the rotor or the like. The motor M is not limited to an electric motor which uses electricity as a power source, and the motor M may be a motor which uses other power sources such as a hydraulic motor, a pneumatic motor, or a steam motor, for example. Here, for the sake of convenience of the description, the description is made with respect to the case where the motor M is an electric motor hereinafter.

[0017]

The encoder 100 is connected to the shaft SH on a side (also referred to as "an opposite-to-load side") opposite to a rotational force output side (also referred to as "a load side"). A connecting position of the encoder 100 is not limited to the side opposite to the rotational force output side of the shaft SH, and may be the rotational force output side of the shaft SH. The encoder 100 detects the position (also referred to as "a rotation angle") of the rotor by detecting the position of the shaft

SH, and outputs position data indicating the position of the rotor.

[0018]

The encoder 100 is not particularly limited provided that the encoder 100 is an encoder which can detect the position and the like of the rotor. As the encoder 100, a magnetic encoder, an optical encoder, an encoder which adopts both a magnetic method and an optical method (so-called hybrid-type encoder) can be used. Here, for the sake of convenience of the description, the description is made with respect to a case where the encoder 100 is an optical encoder. The optical encoder is roughly classified into a reflection-type encoder and a transmission-type encoder. In this embodiment, it does not matter whether the encoder 100 is a reflection-type encoder or a transmission-type encoder.

[0019]

That is, the encoder 100 includes: a light source; a disc which is connected to the rotor; a light receiving element and the like (none of these components shown in the drawing). In the encoder 100, the light receiving element receives light which is irradiated from the light source and is subjected to action of a slit formed in the disc (light which is reflected on the slit or light which passes through the slit) and generates a detection signal, the

position of the rotor which the detection signal indicates is detected based on the detection signal of the light receiving element, and position data indicating the position of the rotor is outputted.

[0020]

The encoder 100 may be configured to detect at least one of a speed (also referred to as "rotational speed", "angular velocity" or the like) and an acceleration (also referred to as "rotational acceleration", "angular acceleration" or the like) of the rotor in addition to or in place of the position of the rotor. In this case, the speed and the acceleration of the rotor can be detected by applying first-order or second-order differentiation to the position with time or by performing processing such as counting detection signals from the light receiving element for a predetermined time, for example. Here, for the sake of convenience of the description, the description is made with respect to the case where a physical quantity detected by the encoder 100 is the position.

[0021]

The controller CT acquires position data from the encoder 100, and controls the operation of the motor M based on the position data. That is, the controller CT corresponds to one example of a higher-level device. Accordingly, in this embodiment where an electric motor is

used as the motor M, the controller CT controls an operation of the motor M by controlling an electric current, a voltage or the like applied to the motor M based on the position data. Further, the controller CT may be configured to acquire a higher-level control signal from a higher-level controller (not shown in the drawing), and to control an operation of the motor M such that a rotational force which enables the positioning of the rotor to the position indicated by the higher-level control signal or the like is outputted from the shaft SH. When the motor M is a motor using other power source such as a hydraulic pressure, a pneumatic pressure, steam or the like, the controller CT can control an operation of the motor M by controlling the supply of such a power source.

[0022]

<2. Functional configuration of controller and encoder>

Next, the functional configurations of parts of the controller CT and the encoder 100 relating to a function of changing a communication speed are described with reference to Fig. 2 and Fig. 3. In Fig. 2 and Fig. 3, the illustration of parts of the controller CT relating to a function of controlling an operation of the motor M, parts of the encoder 100 relating to a function of generating position data and the like is omitted.

[0023]

As shown in Fig. 2 and Fig. 3, the controller CT and the encoder 100 are connected to each other in a mutually communicable manner via a wired transmission line or a radio transmission line. The controller CT includes: a communication part 209; a parameter setting part 212; a communication control part 210; a communication stop part 214; and a higher-level speed setting part 211. The encoder 100 includes: a communication part 109; a communication control part 110; a determination part 113; and a speed setting part 111.

[0024]

The communication part 209 of the controller CT performs the communication with the encoder 100. To be more specific, the communication part 209 performs the acquisition of a signal outputted from the communication control part 210, the transmission of the signal to the encoder 100, the reception of a signal transmitted from the encoder 100, and the outputting of the signal to the communication control part 210.

[0025]

In this embodiment, the communication part 209 can perform the communication with the encoder 100 at a plurality of predetermined speeds. That is, the communication part 209 can set its communication speed with the encoder 100 (hereinafter, also referred to as

"controller-side communication speed") at a plurality of predetermined speeds. Values and the number of the controller-side communication speeds which the communication part 209 can set are not particularly limited. However, for the sake of convenience of the description, hereinafter, the description is made with respect to the case where the number of controller-side communication speeds which the communication device 209 can set is two.

[0026]

That is, the communication part 209 can perform the communication with the encoder 100 at two speeds, that is, a speed V1 (for example, 4 Mbps) and a speed V2 (for example, 8 Mbps) higher than the speed V1. That is, the communication part 209 can set the controller-side communication speed at two speeds, that is, the speed V1 and the speed V2. The controller-side communication speed may be initially set to any one of the speed V1 and the speed V2. However, for the sake of convenience of the description, hereinafter, the description is made with respect to the case where the controller-side communication speed is initially set at the speed V1.

[0027]

The communication part 209 includes: a first communication part 209A; a second communication part 209B; and a switching part 209C. The first communication part

209A performs the communication with the encoder 100 at the above-mentioned speed V1 based on a predetermined communication protocol. The second communication part 209B performs the communication with the encoder 100 at the above-mentioned speed V2 based on a predetermined communication protocol. The switching part 209C switches a communication part for performing the communication with the encoder 100 between the first communication part 209A and the second communication part 209B based on a higher-level switching signal described later acquired from the higher-level speed setting part 211 described later.

[0028]

The communication part 109 of the encoder 100 performs the communication with the controller CT. To be more specific, the communication part 109 performs the acquisition of a signal outputted from the communication control part 110, the transmission of the signal to the controller CT, the reception of a signal transmitted from controller CT, and the outputting of the signal to the communication control part 110.

[0029]

In this embodiment, the communication part 109 can perform the communication with the controller CT at a plurality of predetermined speeds. That is, the communication part 109 can set its communication speed with

the controller CT (hereinafter, also referred to as "an encoder-side communication speed") at the plurality of predetermined speeds. Values and the number of the encoder-side communication speeds which the communication part 109 can set are not particularly limited. However, for the sake of convenience of the description, hereinafter, the description is made with respect to the case where the number of encoder-side communication speeds which the communication device 109 can set is two.

[0030]

The communication part 109 includes: a first communication part 109A; a second communication part 109B; and a switching part 109C. The first communication part 109A performs the communication with the controller CT at the above-mentioned speed V1 based on a predetermined communication protocol. The second communication part 109B performs the communication with the controller CT at the above-mentioned speed V2 based on a predetermined communication protocol. The switching part 109C switches a communication part for performing the communication with the controller CT between the first communication part 109A and the second communication part 209B based on a switching signal described later acquired from the speed setting part 111 described later.

[0031]

The parameter setting part 212 of the controller CT sets parameters (hereinafter also referred to as "speed parameters") including the second speed higher than the first speed set as the present encoder-side communication speed in response to a manipulation performed by a user. The parameter setting part 212 outputs parameter data showing set speed parameters to a first command transmission part 210A described later which is included in the communication control part 210.

[0032]

As described above, in this embodiment where an encoder-side communication speed can be set at two speeds, that is, a speed V1 and a speed V2, it is sufficient for the parameter setting part 212 to set a speed parameter indicating the speed V2 as a second speed while assuming a first speed as the speed V1. The speed parameter which the parameter setting part 212 sets is not limited to the parameter including the second speed V2, and may be any parameter provided that the parameter includes a speed higher than the first speed. However, when the parameter setting part 212 sets a speed parameter indicating a speed other than the speed V2 as the second speed, an encoder-side communication speed cannot be set at the speed and hence, the encoder-side communication speed is not changed to the speed and is maintained at the speed V1.

[0033]

The communication control part 210 of the controller CT controls the transmission and the reception of a signal between the controller CT and the encoder 100 through communication via the communication part 209. The communication control part 210 includes the first command transmission part 210A.

[0034]

The first command transmission part 210A transmits a change command for changing an encoder-side communication speed to a second speed to the encoder 100 at a first speed via the communication part 209. In this case, the first command transmission part 210A outputs transmission time data indicating a transmission time of the change command to the higher-level speed setting part 211. The speed change command corresponds to one example of a first command signal. When the first command transmission part 210A transmits a change command, a controller-side communication speed is initially set to a speed V1. That is, the communication part is switched to the first communication part 209A. Accordingly, the first command transmission part 210A transmits a change command at the speed V1 via the first communication part 209A.

[0035]

In this case, the first command transmission part

210A acquires parameter data from the parameter setting part 212, and transmits a change command including a speed parameter expressed by the parameter data. The first command transmission part 210A may transmit a change command including a speed parameter (fixed value) indicating a preset second speed or may transmit a change command which does not include a speed parameter. In this case, the above-mentioned parameter setting part 212 becomes unnecessary. However, for the sake of convenience of the description, hereinafter, the description is made with respect to the case where the first command transmission part 210A transmits a change command including a speed parameter expressed by the above-mentioned parameter data.

[0036]

In this embodiment, the first command transmission part 210A repeatedly transmits a change command for a predetermined period (for example, for a period of 75 ms) at predetermined time intervals (for example, intervals of 25 ms) or less or a predetermined number of times (for example, three times). The first command transmission part 210A may transmit a change command only one time or may transmit a change command repeatedly until a first response described later is received. However, for the sake of convenience of the description, hereinafter, the

description is made with respect to a case where the first command transmission part 210A repeatedly transmits a change command a predetermined number of times at predetermined time intervals or less.

[0037]

Fig. 4A shows one example of data structure of a change command.

[0038]

In the example shown in Fig. 4A, a change command contains sixteen data D0 to D15. Data D0 has the content expressing that data is a change command. Data D1 is blanked. Data D2 is a speed parameter. With respect to data D3 to D15, although the description is omitted, each data is filled with certain content or is blanked.

[0039]

Data structure of the change command shown in Fig. 4A is merely one example, and the change command may have data structure other than the above-mentioned data structure.

[0040]

As shown in Fig. 2 and Fig. 3, the communication control part 110 of the encoder 100 controls the transmission and the reception of a signal between the encoder 100 and the controller CT through the communication via the communication part 109. The communication control part 110 includes a command response part 110A.

[0041]

The command response part 110A receives a signal transmitted from the controller CT via the communication part 109. In this case, the command response part 110A outputs a signal indicating the reception of the signal from the controller CT (hereinafter, also referred to as a "signal receiving signal") to the determination part 113. Further, when the command response part 110A receives the signal from the controller, the command response part 110A transmits a response to the signal to the controller CT via the communication part 109.

[0042]

That is, the command response part 110A receives a change command transmitted from the controller CT via the communication part 109. In this case, the command response part 110A outputs reception time data showing a reception time of the change command to the determination part 113. When the command response part 110A receives the change command, an encoder-side communication speed is initially set to a speed V1. That is, the communication part is switched to the first communication part 109A. Accordingly, the command response part 110A receives a change command via the first communication part 109A. Further, when the command response part 110A receives a change command, the command response part 110A transmits a response to the

change command (hereinafter also referred to as "first response") to the controller CT at a speed V1 via the first communication part 109A. In this case, the command response part 110A outputs a signal indicating the transmission of the response (hereinafter referred to as "response transmission signal") to the determination part 113. A first response corresponds to one example of a first response signal.

[0043]

In this case, when an encoder-side communication speed can be set to a second speed, that is, when a second speed is a speed V2, the command response part 110A transmits a first response including the fact that the second speed is the speed V2. On the other hand, when an encoder-side communication speed cannot be set to a second speed, that is, the second speed is a speed other than a speed V2, the command response part 110A transmits a first response including the fact that the second speed is the speed other than the speed V2. The command response part 110A may transmit the first response only when the encoder-side communication speed can be set to the second speed. However, for the sake of convenience of the description, hereinafter, the description is made with respect to a case where when the command response part 110A receives a change command, the command response part 110A transmits a first

response regardless of whether or not an encoder-side communication speed can be set to a second speed.

[0044]

Fig. 4B shows one example of data structure of a first response.

[0045]

In the example shown in Fig. 4B, the first response has the data structure where a status flag is allocated to data D1 of a change command shown in Fig. 4A. The status flag indicates whether or not an encoder-side communication speed can be set to a second speed expressed in a speed parameter of data D2. For example, when an encoder-side communication speed can be set to a second speed expressed in a speed parameter of data D2, that is, when the second speed is a speed V2, the status flag in data D1 indicates that the encoder-side communication speed can be set to the second speed. On the other hand, when an encoder-side communication speed cannot be set to a second speed expressed in a speed parameter in data D2, that is, when the second speed is a speed other than the speed V2, the status flag of data D1 indicates that the encoder-side communication speed cannot be set to the second speed.

[0046]

Data structure of a first response shown in Fig. 4B is merely one example, and the first response may have data

structure other than the above-mentioned data structure.

[0047]

As shown in Fig. 2 and Fig. 3, when the determination part 113 of the encoder 100 acquires the above-mentioned reception time data from the command response part 110A, the determination part 113 detects a reception time of a change command based on the reception time data. Further, when the determination part 113 acquires the above-mentioned response transmission signal from the command response part 110A, the determination part 113 determines whether or not the above-mentioned signal reception signal can be acquired from the command response part 110A before a first period (for example, 30 ms) elapses from a point of time that the detected change command is received. Then, the determination part 113 outputs a signal indicating a determination result (hereinafter also referred to as "determination signal") to a speed changing part 111A described later of the speed setting part 111.

[0048]

The speed setting part 111 of the encoder 100 changes an encoder-side communication speed by outputting a signal for switching a communication part for performing the communication between the encoder 100 and the controller CT (hereinafter also referred to as "switching signal") to the switching part 109C. The speed setting part 111 includes

the speed changing part 111A.

[0049]

The speed changing part 111A, when the command response part 110A receives a change command, outputs a switching signal for switching a communication part for performing the communication between the encoder 100 and the controller CT to the second communication part 109B to the switching part 109C thus changing an encoder-side communication speed to a second speed, that is, to a speed V2. Accordingly, in this embodiment where the controller CT transmits a change command containing a speed parameter, the speed changing part 111A changes an encoder-side communication speed to a speed V2 expressed by a speed parameter contained in the change command. When the controller CT transmits a change command which does not include a speed parameter, it is sufficient for the speed changing part 111A to change an encoder-side communication speed to a preset speed V2.

[0050]

In this case, the speed changing part 111A changes an encoder-side communication speed to a speed V2 when the command response part 110A transmits a first response expressing that the encoder-side communication speed can be set to a speed V2 to the controller CT. To be more specific, the speed changing part 111A changes an encoder-

side communication speed to a speed V2 after at least a first period elapses from a point of time that the command response part 110A receives a change command. To be still more specific, the speed changing part 111A acquires a determination signal from the determination part 113, and changes or does not change an encoder-side communication speed to a speed V2 based on a determination result of the determination part 113 expressed by the determination signal. That is, the speed changing part 111A changes an encoder-side communication speed to a speed V2 when a determination result from the determination part 113 indicates that the determination part 113 does not receive a signal reception signal from the command response part 110A before the first period elapses. On the other hand, the speed changing part 111A does not change an encoder-side communication speed to a speed V2 and maintains the encoder-side communication speed at a speed V1 when a determination result from the determination part 113 indicates that the determination part 113 receives a signal reception signal from the command response part 110A before a first period elapses.

[0051]

When the command response part 110A receives a change command and an encoder-side communication speed can be set to a second speed, the speed changing part 111 may change

the encoder-side communication speed to a second speed even when a first response is not transmitted to the controller CT. In this case, it becomes unnecessary for the command response part 110A to have a function of transmitting a first response to the controller CT. However, for the sake of convenience of the description, hereinafter, the description is made with respect to a case where the speed changing part 111 changes an encoder-side communication speed to a second speed when the command response part 110A receives a change command, the encoder-side communication speed can be set to the second speed, and the command response part 110A transmits a first response to the controller CT. Further, the speed changing part 111A may change an encoder-side communication speed to a speed V2 before a first period elapses (for example, immediately after the command response part 110A receives a change command). However, for the sake of convenience of the description, hereinafter, the description is made with respect to a case where the speed changing part 111A changes an encoder-side communication speed to a speed V2 after at least a first period elapses. Further, the speed changing part 111A may change an encoder-side communication speed to a speed V2 after at least a first period elapses regardless of whether or not the command response part 110A receives a signal from the controller CT before a first

period elapses. In this case, the above-mentioned determination part 113 becomes unnecessary. However, for the sake of convenience of the description, hereinafter, the description is made with respect to a case where the speed changing part 111A does not change an encoder-side communication speed to a speed V2 when the command response part 110A receives a signal from the controller CT before a first period elapses.

[0052]

The communication control part 210 of the controller CT receives a first response transmitted from the encoder 100 via the communication part 209. In this case, the communication control part 210 outputs a signal indicating the reception of the first response (hereinafter also referred to as "response reception signal") to the communication stop part 214. When the communication control part 210 receives a first response, a controller-side communication speed is initially set to a speed V1. That is, the communication part is switched to the first communication part 209A. Accordingly, the communication control part 210 receives a first response via the first communication part 209A.

[0053]

When the communication stop part 214 of the controller CT acquires the above-mentioned response reception signal

from the communication control part 210, the communication stop part 214 detects whether or not the fact that an encoder-side communication speed can be set to a second speed is included in a first response based on the response reception signal. There may be a case where the fact that the encoder-side communication speed can be set to the second speed is included in the first response. In this case, the communication stop part 214 outputs a signal for stopping the communication between the controller CT and the encoder 100 (hereinafter also referred to as "stop signal") to the communication control part 210 until a change of a controller-side communication speed is completed. Due to such outputting of the stop signal, the communication stop part 214 stops the communication between the controller CT and the encoder 100 by the communication part 209. The communication stop part 214 may stop only the transmission of a change command by the first command transmission part 210A and may not stop the transmission and the reception of other signals by the communication part 209. However, for the sake of convenience of the description, hereinafter, the description is made with respect to a case where the communication stop part 214 stops all communications between the controller CT and the encoder 100 by the communication part 209. Further, when the communication between the controller CT and the encoder

100 by the communication part 209 is stopped, the communication stop part 214 outputs a signal expressing the stopping of the communication between the controller CT and the encoder 100 (hereinafter also referred to as "stop completion signal") to the higher-level speed setting part 211.

[0054]

The higher-level speed setting part 211 of the controller CT changes a controller-side communication speed by outputting a signal for switching a communication part for performing the communication between the controller CT and the encoder 100 (hereinafter also referred to as "higher-level switching signal") to the switching part 209C.

[0055]

That is, when the higher-level speed setting part 211 acquires the above-mentioned transmission time data from the first command transmission part 210A, the higher-level speed setting part 211 detects a transmission time of a change command based on the transmission time data. Further, the higher-level speed setting part 211, when the communication control part 210 receives a first response, changes a controller-side communication speed to a speed V2 by outputting a higher-level switching signal for switching a communication part for performing the communication between the controller CT and the encoder 100 to the second

communication part 209B to the switching part 209C after at least a second period (for example, 40 ms) longer than the above-mentioned first period elapses from a point of time that the detected change command is transmitted. To be more specific, the higher-level speed setting part 211 changes the controller-side communication speed to the speed V2 after at least the second period elapses after the higher-level speed setting part 211 acquires a stop completion signal from the communication stop part 214. Then, when the controller-side communication speed is changed to the speed V2, the higher-level speed setting part 211 outputs a signal indicating a change of the controller-side communication speed to the speed V2 (hereinafter also referred to as "change completion signal") to a second command transmission part 210B described later included in the communication control part 210.

[0056]

The communication control part 210 of the controller CT includes the second command transmission part 210. The second command transmission part 210 acquires a change completion signal from the higher-level speed setting part 211 and, thereafter, transmits a confirmation command for confirming whether or not the speed setting part 111 of the encoder 100 changes an encoder-side communication speed to

a speed V2 to the encoder 100 at the speed V2 via the second communication part 209A. The confirmation command corresponds to one example of the second command signal.

[0057]

The command response part 110A of the encoder 100 receives a confirmation command transmitted from the controller CT via the second communication part 109B. When the command response part 110A receives a confirmation command, the command response part 110A transmits a response to the confirmation command (hereinafter also referred to as "second response") to the controller CT at the speed V2 via the second communication part 109B. The second response corresponds to one example of a first response signal. When the encoder-side communication speed is not set at the speed V2, the command response part 110A cannot receive the confirmation command, and a second response is not transmitted to the controller CT from the command response part 110A.

[0058]

The communication control part 210A of the controller CT receives a second response transmitted from the encoder 100 via the second communication part 209B. Accordingly, it is confirmed that an encoder-side communication speed is changed to a speed V2, and the subsequent communication between the controller CT and the encoder 100 is performed

at the speed V2.

[0059]

The above-mentioned series of processing relating to the transmission and the reception of a confirmation command and the transmission and the reception of a second response are not always necessary and may be omitted. In this case, it becomes unnecessary for the second command transmission part 210 and the command response part 110A to have the above-mentioned function of receiving a confirmation command and the above-mentioned function of transmitting a second response, and it becomes unnecessary for the communication control part 210A to have the above-mentioned function of receiving a second response. Here, for the sake of convenience of the description, hereinafter, the description is made with respect to a case where a series of processing relating to the above-mentioned transmission and reception of a confirmation command and the above-mentioned transmission and reception of a second response are performed.

[0060]

The speed setting part 111 of the encoder 100 includes a speed initializing part 111B. The speed initializing part 111B initializes an encoder-side communication speed to a speed V1 by outputting a switching signal for switching a communication part for performing the

communication between the encoder 100 and the controller CT to the first communication part 109A to the switching part 109C when the power source of the encoder 100 is interrupted.

[0061]

In the controller CT and the encoder 100 shown in Fig. 2 and Fig. 3, the dividing of the functional configurations of the parts relating to the function of changing the communication speed is merely one example, and other dividing may be adopted.

[0062]

<3. One example communication between controller and encoder>

Next, one example of the communication between the controller CT and the encoder 100 is described with reference to Fig. 5. In Fig. 5, the behavior of the communication between the controller CT and the encoder 100 is indicated by arrows which laterally connect the controller CT and the encoder 100 indicated by vertical lines respectively to each other. The direction of arrow indicates the direction of communication, and a side toward which the arrow is directed is a reception side. In the drawing, a time axis is taken downwardly, and Fig. 5 shows that the more downwardly the time axis extends, the more time elapses.

[0063]

In the example shown in Fig. 5, firstly, at a point of time t_1 , the first command transmission part 210A of the controller CT transmits a change command to the encoder 100 at a speed V_1 via the first communication part 209A. Next, at a point of time t_2 after a predetermined interval of time elapses from the above-mentioned point of time t_1 , the first command transmission part 210A of the controller CT transmits a change command to the encoder 100 at a speed V_1 via the first communication part 209A. Then, at a point of time t_3 after a predetermined interval of time elapses from the above-mentioned time t_2 , the first command transmission part 210A of the controller CT transmits a change command to the encoder 100 at a speed V_1 via the first communication part 209A.

[0064]

Then, at a point of time t_4 , the command response part 110A of the encoder 100 receives the change command transmitted from the controller CT at the above-mentioned point of time t_3 via the first communication part 109A. Thereafter, at a point of time t_5 , the command response part 110A of the encoder 100 transmits a first response to the change command which the command response part 110A receives at the above-mentioned point of time t_4 at the speed V_1 via the first communication part 109A.

[0065]

Then, at a point of time t_6 , the communication control part 210 of the controller CT receives the first response transmitted from the encoder 100 at the above-mentioned point of time t_5 via the first communication part 209A. Thereafter, the communication stop part 214 of the controller CT stops the communication between the controller CT and the encoder 100.

[0066]

When the first period elapses from the above-mentioned point of time t_4 and a point of time t_7 comes, the speed changing part 111A of the encoder 100 changes the encoder-side communication speed to the speed V_2 .

[0067]

Then, when the second period elapses from the above-mentioned point of time 3 and a point of time t_8 comes, the higher-level speed changing part 211 of the controller CT changes the controller-side communication speed to the speed V_2 . Thereafter, at a point of time t_9 , the second command transmission part 210B of the controller CT transmits a confirmation command to the encoder 100 at the speed V_2 via the second communication part 209B.

[0068]

Then, at a point of time t_{10} , the command response part 110A of the encoder 100 receives the confirmation

command transmitted from the controller CT at the above-mentioned point of time t_9 via the second communication part 109B. Thereafter, at a point of time t_{11} , the command response part 110A of the encoder 100 transmits a second response to the confirmation command which the command response part 110A receives at the above-mentioned point of time t_{10} at a speed V_2 via the second communication part 109B.

[0069]

Then, at a point of time t_{12} , the communication control part 210 of the controller CT receives the second response transmitted from the encoder 100 at the above-mentioned point of time t_{11} via the second communication part 209B.

[0070]

The communication between the controller CT and the encoder 100 shown in Fig. 5 is merely one example, and the communication between the controller CT and the encoder 100 is not limited to the above-mentioned flow shown in Fig. 5.

[0071]

<4. One example of control steps performed by controller and encoder>

Next, the description is made with respect to one example of the processing for controlling the parts relating to a function of changing a communication speed

performed between the controller CT and the encoder 100 with reference to Fig. 6. In Fig. 6, the illustration of the parts relating to the function of controlling the operation of the motor M of the controller CT and the parts relating to the function of generating position data of the encoder 100 and the like are omitted.

[0072]

As shown in Fig. 6, in step SA5, firstly, the parameter setting part 212 of the controller CT sets a speed parameter according to an operation of a user.

[0073]

Thereafter, in step SA10, the first command transmission part 210A of the controller CT transmits a change command including a speed parameter set in the above-mentioned step SA5 to the encoder 100 at a speed V1 via the first communication part 209A. The processing in step SA10 is repeatedly performed a predetermined number of times at predetermined time intervals or less.

[0074]

In step SB10, the command response part 110A of the encoder 100 is in a standby state for receiving a change command transmitted from the controller CT in the above-mentioned step SA10 via the first communication part 109A, and when the command response part 110A receives the change command, the processing advances to step SB20.

[0075]

In step SB20, the command response part 110A of the encoder 100 transmits a first response to the change command which the command response part 110A receives in the above-mentioned step SB10 to the controller CT at a speed V1 via the first communication part 109A. To be more specific, when an encoder-side communication speed can be set to a second speed expressed by a speed parameter included in a change command (when the second speed is the speed V2), the command response part 110A transmits a first response including the fact that the second speed is the speed V2, and the processing advances to step SB30. On the other hand, when an encoder-side communication speed cannot be set to a second speed expressed by a speed parameter included in a change command (the second speed is a speed other than the speed V2), the command response part 110A transmits a first response including the fact that the second speed is a speed other than the speed V2, and the processing advances to the above-mentioned step SB10. Fig. 6 shows that, in step SB20, the command response part 110A transmits a first response including the fact that an encoder-side communication speed can be set to a second speed expressed by a speed parameter included in a change command, and the processing advances to step SB30.

[0076]

In step SB30, the determination part 113 of the encoder 100 determines whether or not the determination part 113 acquires the above-mentioned signal reception signal from the command response part 110A before a first period elapses from a point of time that the determination part 113 receives a change command in the above-mentioned step SB10. When the determination part 113 acquires the signal reception signal before the first period elapses, the processing advances to step SB40.

[0077]

In step SB40, the speed changing part 111A of the encoder 100 does not change an encoder-side communication speed to a speed V2 and maintains the encoder-side communication speed at a speed V1, and the processing advances to step SB20.

[0078]

On the other hand, when the determination part 113 does not acquire a signal reception signal before a first period elapses in the above-mentioned step SB30, the processing advances to step SB50.

[0079]

In step SB50, the speed changing part 111A of the encoder 100 changes an encoder-side communication speed to a speed V2.

[0080]

In step SA20, when the communication control part 210 of the controller CT does not receive a first response transmitted from the encoder 100 in the above-mentioned step SB20 before a predetermined period elapses from a point of time that the communication control part 210 transmits a change command in step SA10, the processing advances to step SA25. Also when the communication control part 210 receives a first response which is transmitted from the encoder 100 in the above-mentioned step SB20 and includes the fact that an encoder-side communication speed cannot be set to a second speed in step SA20, the processing advances to step SA25.

[0081]

In step SA25, the higher-level speed changing part 211 of the controller CT does not change a higher-level-device-side communication speed to a speed V2 and maintains the higher-level-device-side communication speed at a speed V1, and the processing expressed by a sequence of the controller CT is finished.

[0082]

On the other hand, when the communication control part 210 receives a first response which is transmitted from the encoder 100 in the above-mentioned step SB20 and includes the fact that an encoder-side communication speed can be set to a second speed in the above-mentioned step

SA20, the processing advances to step SA30.

[0083]

In step SA30, the communication stop part 214 of the controller CT stops the communication between the controller CT and the encoder 100 by the communication part 209, and the processing advances to step SA40.

[0084]

In step SA40, the higher-level speed setting part 211 of the controller CT changes a controller-side communication speed to a speed V2 after at least the second period elapses from a point of time that the communication control part 210 transmits a change command in step SA10, and the processing advances to step SA50.

[0085]

In step SA50, the second command transmission part 210 of the controller CT transmits a confirmation command to the encoder 100 at a speed V2 via the second communication part 209A.

[0086]

In step SB60, the command response part 110A of the encoder 100 is in a standby state for receiving a confirmation command transmitted from the controller CT in the above-mentioned step SA50 via the second communication part 109B. When the command response part 110A receives the confirmation command, the processing advances to step

SB70.

[0087]

In step SB70, the command response part 110A of the encoder 100 transmits a second response to a confirmation command which the command response part 110A receives in step SB60 to the controller CT at a speed V2 via the second communication part 109B. Thereafter, the sequence on an encoder 100 side is finished.

[0088]

In step SA70, when the communication control part 210 of the controller CT does not receive a second response which is transmitted from the encoder 100 in the above-mentioned step SB70 before a predetermined period elapses from a point of time that a confirmation command is transmitted in the above-mentioned step SA50, the processing advances to the above-mentioned step SA10. On the other hand, when the communication control part 210 receives the second response transmitted from the encoder 100 in the above-mentioned step SB70, the sequence on a controller CT side is finished.

[0089]

The control processing performed between the controller CT and the encoder 100 shown in Fig. 6 constitutes merely one example, and the control processing performed between the controller CT and the encoder 100 is

not limited to the above-mentioned flow shown in Fig. 6.

[0090]

<5. Constitutional example of controller and encoder>

Various processing executed by the controller CT and the encoder 100 described above may be executed by one or a plurality of dedicated hardware. However, the various processing may be executed by software. In executing various processing by software, these various processing can be realized by making the controller CT and the encoder 100 shown in Fig. 7 execute programs.

[0091]

Hereinafter, the configurational example of the controller CT and the encoder 100 which realize various processing by executing the program is described with reference to Fig. 7.

[0092]

As shown in Fig. 7, the controller CT includes, for example: a CPU 201; ROM 202; RAM 203; an input device 206 such as a mouse or a keyboard; an output device 207 such as a monitor; a storage device 208 such as an HDD; and a communication device 209. These configurational parts are connected to each other such that signals can be transmitted between these configurational parts through a bus 204 and an input/output interface 205.

[0093]

The program can be recorded in the ROM 202, the storage device 208 or the like, for example.

[0094]

When the CPU 201 executes the processing in accordance with a program recorded in the above-mentioned ROM 202, the storage device 208 or the like, various processing on a controller CT side can be realized. In this case, the CPU 201 may execute various processing by directly reading out the program from the ROM 202, the storage device 208 or the like, or may execute various processing after temporarily loading the program in the RAM 203, for example.

[0095]

Further, the CPU 901 may perform various processing on a controller CT side based on signals and information inputted from the input device 206 when necessary.

[0096]

The CPU 201 may also output a result acquired by executing various processing on a controller CT side from the output device 207, and may also record the result in the above-mentioned storage device 208 or the like.

[0097]

On the other hand, the encoder 100 includes, for example, a CPU 101; ROM 102; RAM 103; a storage device 108 such as an HDD; and a communication device 109. These

configurational parts are connected to each other such that signals can be transmitted between these configurational parts through a bus 104 and an input/output interface 105.

[0098]

The program can be recorded in the ROM 102, the storage device 108 or the like, for example.

[0099]

When the CPU 101 executes the processing in accordance with a program recorded in the above-mentioned ROM 102, storage device 108 or the like, various processing on an encoder 100 side can be realized. In this case, the CPU 101 may execute various processing by directly reading out the program from the ROM 102, the storage device 108 or the like, or may execute various processing after temporarily loading the program in the RAM 103, for example.

[0100]

<6. Example of advantageous effects acquired by this embodiment>

In the servo system S according to this embodiment described above, the first command transmission part 210A of the controller CT transmits a change command for changing an encoder-side communication speed to a second speed higher than a present first speed to the encoder 100. When the encoder 100 receives the change command, the speed setting part 111 of the encoder 100 changes an encoder-side

communication speed to a second speed. Accordingly, the controller CT can change an encoder-side communication speed to a desired speed. As a result, it becomes unnecessary to prepare the encoders 100 which respectively correspond to controller-side communication speeds and hence, the increase of the number of types of the encoders 100 can be prevented.

[0101]

The controller CT changes an encoder-side communication speed and hence, the encoder-side communication speed can be selected on a user side. As a result, for example, when there is a demand for enhancement of control performance of the servo system S by shortening a communication delay time of the encoder 100 or the like, it becomes possible to select a high communication speed. On the other hand, for example, when a communication speed becomes high, a communication delay is generated because of a physical specification of a cable or the like thus giving rise to a possibility of an erroneous detection and hence, a low transmission speed can be selected when reliability of communication is emphasized.

[0102]

As the configuration for switching an encoder-side communication speed, the configuration may be considered where the encoder 100 includes a determination part which

automatically determines a controller-side communication speed based on a signal transmitted from the controller CT. In this case, however, it is necessary to provide the encoder 100 with the determination part or the like and hence, a hardware circuit becomes complicated leading to the increase of a cost. Also in this case, complicated arithmetic operation is performed where a clock signal contained in a signal from the controller CT is detected, a controller-side communication speed is determined, and a communication part is switched. Accordingly, there exists a drawback that a standby time before an encoder-side communication speed is switched becomes prolonged. To the contrary, in this embodiment, a hardware circuit such as a determination part becomes unnecessary and hence, the configuration can be simplified whereby the increase of a cost can be prevented. Further, the encoder 100 changes an encoder-side communication speed in response to a command from the controller CT and hence, the above-mentioned clock signal detection processing and determination processing of a controller-side communication speed become unnecessary whereby a standby time can be shortened.

[0103]

Further, in this embodiment, the first command transmission part 210A of the controller CT transmits a change command to the encoder 100 at a first speed to the

encoder 100. In other words, in changing an encoder-side communication speed, the controller CT performs communication at a lower speed, and changes an encoder-side communication speed to a higher speed. Due to such a configuration, when a communication speed becomes a higher speed as described above, a communication delay is generated because of physical specification thus giving rise to a possibility of erroneous detection. Accordingly, for example, compare to a case where the controller CT performs communication at a higher speed and changes an encoder-side communication speed to a lower speed, the reliability of communication at the time of transmitting a change command can be enhanced.

[0104]

Further, in this embodiment, particularly, when a change command is received, in the case where an encoder-side communication speed can be set at a second speed, the command response part 110A of the encoder 100 transmits a first response to the controller CT. Accordingly, for example, when the controller CT having a higher communication speed is put into a market as a new product, when a change command containing a speed parameter expressing the higher speed is transmitted to the encoder 100, the encoder 100 which can set the higher speed transmits a first response to the controller CT and hence,

the controller CT can recognize the encoder 100. In this manner, even when a higher speed determination part is not newly provided to the encoder 100, the encoder 100 can correspond to communication between the controller CT and the encoder 100 thus acquiring an advantageous effect that downward compatibility can be easily maintained.

[0105]

Further, in this embodiment, particularly, when the command response part 110A transmits a first response to the controller CT, the speed setting part 111 of the encoder 100 changes an encoder-side communication speed to a second speed after at least a first period elapses from reception of a change command. Accordingly, the communication between the encoder 100 and the controller CT can be executed at a first speed which is a speed before being changed to a second speed before the first period elapses and, thereafter, a change of a communication speed is executed. For example, when the controller CT acquires data of the encoder 100 and performs a predetermined setup operation, reliability and certainty are ensured by performing communication at a low speed (a first speed) and, after a lapse of the first period, when the controller CT controls an operation of a motor M based on a detection result of the encoder 100, the controller CT performs communication at a higher speed (second speed) thus

enhancing control performance of the servo system S.

[0106]

Further, this embodiment can acquire the following advantageous effect particularly. That is, when the communication part 109 is executing certain processing (transmission/reception of a signal or the like) at the time of changing a communication speed, there is a possibility that switching of the communication part cannot be executed so that a communication speed cannot be normally changed. In view of the above, in this embodiment, the determination part 113 of the encoder 100 determines whether or not the command response part 110A receives a signal from the controller CT before the first period elapses. Then, when the determination part 113 determines that the command response part 110A has received a signal from the controller CT, the speed setting part 111 does not change an encoder-side communication speed to a second speed. Accordingly, the execution of switching of the communication part is prohibited during a period where the communication part 109 is executing certain processing and hence, it is possible to suppress the occurrence of a state where a communication speed cannot be changed normally. On the other hand, when the determination part 113 determines that the command response part 110A has not received a signal from the controller CT, an encoder-side

communication speed can be changed to a second speed by the speed setting part 111. Accordingly, a non-processing state of the communication part 109 is ensured before the first period elapses and, under such a condition, switching of the communication part can be executed and hence, reliability of a change in communication speed can be enhanced.

[0107]

Further, in this embodiment, particularly, when a first response is received, the speed setting part 211 of the controller CT changes a controller-side communication speed to a second speed after a lapse of at least a second period which is longer than a first period from a point of time that the first command transmission part 210A transmits a first change command. Accordingly, a non-processing state of the communication part 209 of the controller CT is ensured before the second period elapses and under such a condition, switching of the communication part can be executed and hence, reliability of a change in communication speed can be enhanced. Further, by setting the second period ranging from a point of time that a change command is transmitted to a point of time that a communication speed is changed longer than the first period, a time necessary for a change in communication speed on an encoder 100 side can be ensured thus enhancing reliability

of a change in communication speed.

[0108]

Further, in this embodiment, particularly, the higher-level speed setting part 211 of the controller CT changes a controller side communication speed to a second speed and, thereafter, the second command transmission part 210B transmits a confirmation command for confirming whether or not the speed setting part 111 of the encoder 100 has changed an encoder-side communication speed to a second speed to the encoder 100. After receiving a confirmation command, when the encoder-side communication speed is set to the second speed, the command response part 110A of the encoder 100 transmits a second response to the controller CT. Accordingly, it is possible to confirm whether or not an encoder-side communication speed is surely changed before starting communication at a second speed between the controller CT and the encoder 100 and hence, reliability of communication can be further enhanced.

[0109]

Further, in this embodiment, particularly, the parameter setting part 212 of the controller CT sets speed parameter containing a desired second speed. Then, the speed setting part 211 of the encoder 100 changes an encoder side communication speed to a second speed expressed by a speed parameter contained in a change

command. Accordingly, a user can easily perform a change or addition of the second speed thus enhancing general-use property of a change command.

[0110]

Further, in this embodiment, particularly, the speed setting part 111 of the encoder 100 includes a speed initializing part 111B for initializing an encoder-side communication speed to a first speed when a power source of the encoder 100 is interrupted. The controller CT firstly performs communication with the encoder 100 at a first speed and hence, even when communication cannot be performed between the controller CT and the encoder 100 (because of difference in communication speed) due to the above-mentioned configuration, the communication between the encoder 100 and the controller CT can be restored by interrupting a power source of the encoder 100.

[0111]

<7. Modifications and the like>

One embodiment has been described in detail with reference to attached drawings heretofore. However, the scope of the technical concept described in Claims is not limited to the embodiment described in this specification. It is evident that those who are skilled in the art in the technical field to which the embodiment of this disclosure pertains can arrive at various changes, modifications,

combinations and the like within the scope of the technical concept of this disclosure. Accordingly, it is a matter of course that techniques which are made after these changes, modifications, combinations and the like are made also belong to the scope of the technical concept of this disclosure. Hereinafter, such modifications and the like are described sequentially.

[0112]

In the above-mentioned embodiment, the description has been made with respect to the case where the controller CT transmits a change command for changing an encoder-side communication speed to a second speed higher than a present first speed to the encoder 100 at the first speed so that when the encoder 100 receives the change command, the encoder changes the encoder-side communication speed to the second speed. However, the embodiment of this disclosure is not limited to such content. For example, a case may be also considered where the controller CT transmits a change command for changing an encoder-side communication speed to a speed lower than a present speed to the encoder 100 at the present speed, and the encoder 100 changes the encoder-side communication speed to the slow speed when the encoder 100 receives the change command.

[0113]

The embodiment of this disclosure is not limited to

the case where a communication speed between the controller CT and the encoder 100 is changed, the embodiment is also applicable to a case where a transmission code of communication between the controller CT and the encoder 100 is changed. As the transmission code, transmission codes in various directions such as an RZ signal, an NRZ signal, an NRZI signal, an AMI signal, a CMI signal, a Manchester signal are named.

[0114]

That is, as a type of transmission code for communication between the controller CT and the encoder 100, one type of transmission code is initially set. Then, for example, when it is necessary to change a type of transmission code due to the restriction imposed on parts forming a physical layer or the like, the controller CT transmits a command signal (hereinafter referred to as "third command signal") which changes a type of transmission code for communication to a transmission code (hereinafter referred to as "second transmission code") which differs from a present transmission code (hereinafter referred to as "first transmission code") to the encoder 100 using the first transmission code. Then, when the encoder 100 receives the third command signal, a type of transmission code for communication is changed to the second transmission code. Accordingly, the controller CT

can change a type of transmission code on an encoder 100 side to a desired transmission code. As a result, it becomes unnecessary to prepare the encoders 100 which respectively correspond to types of transmission codes on a controller side and hence, the increase of the number of types of the encoders 100 can be prevented. Further, the controller CT changes types of transmission codes on an encoder 100 side and hence, a type of transmission code can be selected on a user side.

[0115]

In the case where a type of a transmission code can be set to a second transmission code when the encoder 100 receives a third command signal, the encoder 100 transmits a response signal (hereinafter, also referred to as "third response signal") to the controller. When the encoder 100 transmits the third response signal to the controller CT, a type of transmission code on an encoder 100 side may be changed to a second transmission code.

[0116]

In this case, when the encoder 100 transmits the third response signal to the controller CT, after at least a predetermined time (hereinafter, also referred to as "third period") has elapsed from the reception of the third command signal, a type of transmission code on an encoder 100 side may be changed to a second transmission code.

[0117]

In this case, the encoder 100 determines whether or not the encoder 100 receives a signal from the controller CT before the third period elapses. When the encoder 100 receives a signal from the controller CT before the third period elapses, a type of a transmission code on an encoder 100 side may not be changed to a second transmission code.

[0118]

In this case, when the controller CT receives the third response signal, after at least a predetermined time (hereinafter, also referred to as "fourth period") which is longer than the third period has elapsed from the transmission of the third command signal, a type of transmission code on an encoder 100 side may be changed to a second transmission code.

[0119]

In this case, the controller CT may, after changing a type of transmission code on a controller CT side to a second transmission code, transmit a command signal (hereinafter, also referred to as "fourth command signal") for confirming whether or not the encoder 100 changes a type of transmission code on an encoder 100 side to a second transmission code to the encoder 100. In the case where a type of transmission code on an encoder 100 side is set to a second transmission code when the encoder 100

receives the fourth response signal, a response signal (hereinafter, also referred to as "fourth response signal") may be transmitted to the controller CT.

[0120]

In this case, the controller CT sets parameters containing a second transmission code, and the encoder 100 may change a type of transmission code on an encoder 100 side to a second transmission code expressed in the parameters contained in the third command signal.

[0121]

In this case, when a power source for the encoder 100 is interrupted, the encoder 100 may initialize a type of transmission code on an encoder 100 side to the first transmission code.

[0122]

The embodiment of this disclosure is also applicable to a case where both a communication speed between the controller CT and the encoder 100 and a transmission code for communication between the controller CT and the encoder 100 are changed.

[0123]

Arrows shown in Fig. 1 to Fig. 3 indicate one example of the flow of signals, and are not provided for limiting the flow directions of the signals.

[0124]

The sequence shown in Fig. 6 is not limited to steps illustrating the content of the embodiment, and the addition of steps, the deletion of steps and a change in order of steps and the like may be performed without departing from the gist and the technical concept of this disclosure.

[0125]

Besides the above-mentioned cases, techniques disclosed in the above-mentioned embodiment and the respective modifications can be used by suitably combining these techniques.

[0126]

Although not illustrated one by one, the above-mentioned embodiment and the respective modifications are carried out with various changes without departing from the gist of the present invention.

Reference Signs List

[0127]

100: encoder

CT: controller (one example of a higher-level device)

M: motor

S: servo system

110A: command response part

111: speed setting part

111B: speed initializing part
113: determination part
210A: first command transmission part
210B: second command transmission part
211: higher-level speed setting part
212: parameter setting part

CLAIMS

1. A servo system comprising:

a motor wherein a movable element is configured to move relative to a stator;

an encoder configured to detect at least one of a position and a speed of the movable element; and

a higher-level device configured to control an operation of the motor based on a detection result of the encoder; wherein

the higher-level device includes a first command transmission part configured to transmit a first command signal for changing a communication speed between the encoder and the higher-level device to a second speed higher than a present first speed to the encoder at the first speed;

the encoder includes:

a speed setting part configured to change the communication speed between the encoder and the higher-level device to the second speed after at least a first period elapses from the reception of the first command signal and when the communication speed between the encoder and the higher-level device is capable of being set of the second speed; and

a determination part configured to determine whether

or not the encoder receives a signal from the higher-level device before the first period elapses; and

the speed setting part is configured not to change the communication speed between the encoder and the higher-level device to the second speed, when the determination part determines that the signal is received from the higher-level device.

2. The servo system according to claim 1, wherein

the encoder further includes a command response part configured to transmit a first response signal to the higher-level device, when the first command signal is received and when the communication speed between the encoder and the higher-level device is capable of being set to the second speed;

the speed setting part is configured to change the communication speed between the encoder and the higher-level device to the second speed after at least the first period elapses from the reception of the first command signal, when the command response part transmits the first response signal to the higher-level device; and

the determination part is configured to determine whether or not the command response part receives a signal from the higher-level device before the first period elapses.

3. The servo system according to claim 2, wherein the higher-level device further includes a higher-level speed setting part configured to change the communication speed between the higher-level device and the encoder to the second speed, after at least a second period longer than the first period elapses from a point of time that the first command transmission part transmits the first command signal when the first response signal is received.

4. The servo system according to claim 3, wherein the higher-level device further includes a second command transmission part configured to transmit a second command signal for confirming whether or not the speed setting part changes the communication speed between the encoder and the higher-level device to the second speed, after the higher-level speed setting part changes the communication speed between the higher-level device and the encoder to the second speed to the encoder; and

the command response part is configured to transmit a second response signal to the higher-level device, when the communication speed between the encoder and the higher-level device is set to the second speed when the second command signal is changed.

5. The servo system according to any one of claims 1 to 4, wherein

the higher-level device further includes a parameter setting part configured to set parameters containing the second speed; and

the speed setting part is configured to change the communication speed between the encoder and the higher-level device to the second speed expressed in the parameters included in the first command signal.

6. The servo system according to any one of claims 1 to 5, wherein the speed setting part includes a speed initializing part configured to initialize the communication speed between the encoder and the higher-level device to the first speed when a power source of the encoder is interrupted.

7. An encoder configured to be used in the servo system described in any one of claims 1 to 6.